

## 4. NATURE AND EXTENT OF CONTAMINATION

This section discusses the nature and extent of contamination at each of the retained sites for the Baseline Risk Assessment (BRA). Information detailing the release mechanism responsible for the detected contamination, and the source-term estimates for the Baseline Risk Assessment (BRA) are presented. The data used to identify contaminants and calculate source-term concentrations are summarized in Appendix B.

### 4.1 Summaries of Sites Retained in the RI/FS Work Plan

Screening of all WAG 4 sites was performed in the OU 4-13 Work Plan (McCormick 1997) to identify those sites requiring further investigation, and to identify those sites where the carcinogenic risk for the site contaminants is greater than  $1E-06$  and/or the hazard quotient is greater than one. These sites were retained for inclusion in this BRA. The screening process employed for each positively detected contaminant, a comparison of the maximum detected concentration to the respective background concentration, identification of the six essential nutrients, and a comparison of the maximum detected concentration to the respective risk-based concentration. Using this process, the following sites were retained:

OU 4-02	CFA-13 CFA-15	Dry Well (South of CFA-640) Dry Well (CFA-674)
OU 4-05	CFA-04 CFA-17 CFA-47	Pond (CFA-674) Fire Department Training Area, bermed Fire Station Chemical Disposal
OU 4-06	CFA-06 CFA-43 CFA-44	Lead Shop (outside areas) Lead Storage Area Spray Paint Booth Drain (CFA-654)
OU 4-07	CFA-07 CFA-12	French Drain E/S (CFA-633) French Drains (2) (CFA-690) [south drain only]
OU 4-08	CFA-08  CFA-49	Sewage Plant (CFA-691), Septic Tank (CFA-716), and Drainfield Hot Laundry Drain Pipe
OU 4-09	CFA-10 CFA-26 CFA-42 CFA-46	Transformer Yard Oil Spills CFA-760 Pump Station Fuel Spill Tank Farm Pump Station Spills Cafeteria Oil Tank Spill (CFA-721)
OU 4-11	CFA-05	Motor Pond Pool
OU 4-13	CFA-51 CFA-52	Dry Well at North End of CFA-640 Diesel Fuel UST (CFA-730) at Bldg. CFA-613 Bunkhouse

Contaminant screening was performed in Section 3.4 of the OU 4-13 RI/FS Work Plan at each of the retained sites to identify COPCs. These COPCs were retained for further evaluation in this BRA to

define the nature and extent of contamination at the retained sites. These data used in this BRA are from Track 1 and Track 2 investigations, verification sampling following removal actions, RI/FSs at specific OUs, and characterization data collected during implementation of the Work Plan.

A supplemental contaminant screen is conducted for each retained site as a component of the nature and extent of contamination evaluation. The purpose of the supplemental contaminant screen is to refine the results of the initial contaminant screen presented in the OU 4-13 RI/FS Work Plan and to determine which of the retained sites contain COPCs that require quantitative risk evaluation in the RI/BRA. The supplemental contaminant screen is necessary because removal actions were performed at some of the retained sites after the Work Plan was finalized, therefore additional analytical data is available for those sites. The analytical data used in the supplemental contaminant screen includes OU 4-11 RI/FS data in addition to verification data collected after contaminated soil was removed.

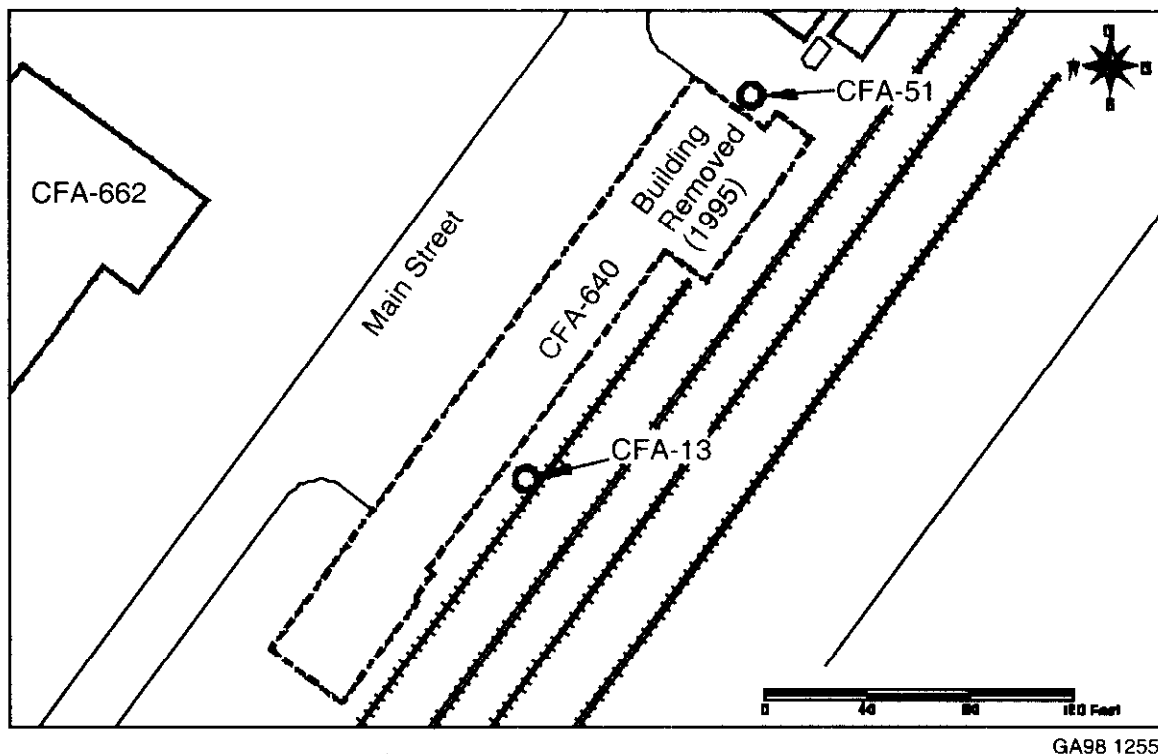
The supplemental contaminant screen is comprised of two screening steps: (1) a comparison of the maximum detected contaminant concentration to the respective background concentration consistent with the Work Plan background values, and (2) a comparison of the maximum detected contaminant concentration to the respective EPA Region III risk-based concentration. If any of the following six (iron, magnesium, calcium, potassium, sodium, and aluminum) was detected, then an essential nutrient screen that involves comparison to ten times the respective background level was used. A contaminant is retained as a COPC if the maximum detected concentration exceeds both screening criteria. Only those contaminants identified as COPCs in the Work Plan are included in the supplemental contaminant screen presented in Appendix C. Results of the screen are discussed in the nature and extent of contamination summaries.

#### **4.1.1 OU 4-02: CFA-13 Dry Well (South of CFA-640)**

**4.1.1.1 Site Summary.** This site consisted of a dry well located south of the demolished locomotive repair shop Building CFA-640, (see Figure 4-1). Building CFA-640 was built in 1950 and provided offices for Security and Power Management, a small area for security physical fitness, a line crew craft area, an automotive repair garage, and a locomotive repair area. The building had a floor drain connected to piping, which ran outside of the building, that was cut and capped. This piping might have run into the CFA-13 dry well; therefore, it is possible that Volatile Organic Compounds (VOCs), Semivolatile Organic Compounds (SVOCs) polychlorinated biphenyl (PCBs), petroleum products, metals, and/or radiological contaminants were discharged to the dry well through this drain (Landis 1998).

**4.1.1.2 Previous Investigations and Removal Actions.** Excavation activities were performed as part of the Track 1 investigation to determine the presence or absence of the dry well. Evidence did not exist at the time of the investigation to indicate that the dry well was ever connected to Building CFA-640 by piping. No record was found pertaining to the dry well's intended use or why it was installed. Personal interviews conducted as part of the Track 1 investigation in July 1995 revealed that the only historical use of the building that may have generated waste products was the locomotive repair area. It was assumed, however, that hazardous substances from this area were not disposed in the dry well because it is located on the opposite side of the building, and oils and greases were reportedly disposed to the waste oil underground storage tanks at Building CFA-665, the large repair shop. In addition, dye tracing tests of the sewer and drain lines indicated that discharge from Building CFA-640 was routed across the tracks to a dry well and may have been tied to a line that runs parallel to Main Street. Consequently, the Track 1 recommendation was "no further action."

Building CFA-640 was demolished in 1995 by the D&D program. Further evidence of the CFA-13 dry well was discovered during demolition, when a floor drain in a former garage area at the north end of the building was discovered. The drain was connected to a buried pipe, which when excavated, ran along



**Figure 4-1.** OU 4-02: CFA-13 Dry Well (South of CFA-640).

the outside south wall of the building. The pipe angled away from the building, where it was cut and sealed. It was believed that this pipe may have been connected to the CFA-13 dry well and that contaminants may have been discharged to the dry well via this drain. Discovery of the buried pipe and floor drain initiated further investigation of the site. The site was retained for further evaluation in the Work Plan (McCormick 1997).

The drywell was excavated during the *WAG 4 Miscellaneous Sites 1997 Non-Time Critical Removal Action*. Soil was excavated to a depth of 1.8 m (6 ft). No dry well was found at this location or within the confines of the demolished CFA-640 building. However, a structure was found that was determined to be a sewer clean out. It was determined that the site thought to be the CFA-13 Dry Well was in fact the found sewer clean-out structure. Therefore, it was decided that the sewer clean-out area would be sampled and the structure removed. After sampling the sewer clean out area, it was backfilled. The sump was thought to exist in the demolished building CFA-640 that may have released contamination to the soil; therefore, excavation continued in an area on the north end of the demolished building in the effort to identify any sump soil contamination. The sump soil contamination was not located during the excavation area sampling; therefore, the area was backfilled. Excavation was again performed on the sewer clean-out area to remove the structure and the approximately 9 m (30 ft) of associated piping. The material was disposed at the CFA Bulky Waste Landfarm. After the final excavation, the removal area was backfilled. The post-removal samples were analyzed for metals, VOCs, SVOCs, and polycyclic aromatic hydrocarbons (PAH). Chromium and 1,1,2-trichloro-1,2,2-trifluoroethane were the only sampled analytes with positively detected concentrations. Sampling results were not available for CFA-13 prior to the October 1997 sampling; therefore, an initial contaminant screen to identify COPCs was not performed in the RI/FS Work Plan. All positively detected chemicals

from the October 1997 sampling were therefore retained for evaluation in the supplemental contaminant screen presented in Appendix C. Tables C-1 through C-3.

The results of the contaminant screen, indicates benzo(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, lead, Am-241, Ra-226, U-235, U-238, and Zr-95 are retained as COPCs for further evaluation in the RI/BRA. Detected concentrations of arsenic are not source related and are assumed to be within the range of background concentrations for INEEL soils. Arsenic is therefore eliminated as a COPC. Benzo(a)anthracene, benzo(b)fluoranthene, and benzo(g,h,i)perylene were all detected in 16.7 percent of 6 samples. Lead was detected in 100 percent of 10 samples. Am-241 was detected in 28.6 percent of 14 samples. Ra-226 was detected in 85.7 percent of 7 samples. U-235 was detected in 64.3 percent of 14 samples. U-238 was detected in 100 percent of 7 samples, and Zr-95 was detected in 14.3 percent of 7 samples. The range of detected concentrations of these COPCs is as follows:

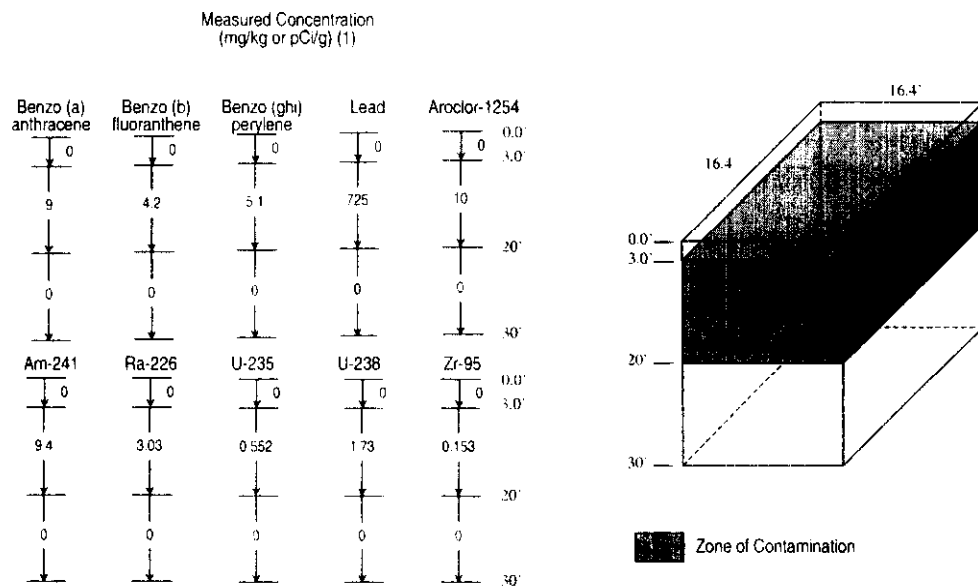
Benzo(a)anthracene	9 mg/kg (only one positive detection is reported)
Benzo(b)fluoranthene	4.2 mg/kg (only one positive detection is reported)
Benzo(g,h,i)perylene	5.1 mg/kg (only one positive detection is reported)
Lead	6.8 to 725 mg/kg
Am-241	0.0207 to 9.397 pCi/g
Ra-226	1.38 to 3.37 pCi/g
U-235	0.0356 to 0.552 pCi/g
U-238	0.753 to 2.53 pCi/g
Zr-95	0.153 pCi/g (only one positive detection is reported)

**4.1.1.3 Nature and Extent of Contamination.** Data from the 1997 removal activities are used in this RI/BRA to characterize the nature and extent of contamination. These data indicate that subsurface soils 0.9 to 6.1 m (3 to 20 ft) bgs at CFA-13 are contaminated with benzo(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, Aroclor-1254, lead, Am-241, Ra-226, U-235, U-238, and Zr-95. The depth of basalt at CFA-13 is unknown; therefore, contamination is assumed to exist in CFA-13 soils from 0.9 to 9.1 m (3 to 30 ft) bgs. This assumption is made to ensure that potential risks from exposures at CFA-13 are not underestimated (Section 6). This assumption is conservative because sample results are not available for depths greater than 6.1 m (20 ft) bgs; however the entire 0 to 9.1m (0 to 30 ft) soil interval is assumed to be contaminated.

The extent of contamination is assumed to encompass the entire site (approximately 25 m<sup>2</sup> [269 ft<sup>2</sup>]). The volume of soil associated with the contamination at CFA-13 is 227.5 m<sup>3</sup> (297 yd<sup>3</sup>) (Figure 4-2). The summary statistics for the CFA-13 COPCs, based on the contaminant screening process, are shown in Tables C-3 and C-4, Appendix C. Figure 4-2 shows the assumptions for the nature and extent of contamination and source-term estimates and exposure point concentrations used to evaluate potential risks associated with the site.

## 4.1.2 OU 4-02: CFA-15 Dry Well (CFA-674)

**4.1.2.1 Site Summary.** This site consisted of a dry well 0.6 m (2 ft) in diameter northwest of Building CFA-674, between the building and Nevada Street (see Figure 4-3). No records were found on this site to indicate that waste was sent to this dry well. However, further investigation identified a floor drain inside building CFA-674 with piping connected to the dry well. Therefore, a potential existed that this dry well may have received laboratory liquid waste and solid calcined wastes (Landis et al., 1998).



Receptors/Pathways and Calculated Exposure Point Concentrations							
Receptor/Pathway	Units	Depth (ft)	Benzo(a) anthracene	Benzo(b) fluoranthene	Benzo(ghi) perylene	Lead	Aroclor-1254
Occ (2) - Air	mg/kg	0-0.5 (1)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Occ (2) - External Radiation	mg/kg	0-4 (2)	7.88E+00	3.68E+00	4.46E+00	6.34E+02	2.50E+00
Res (3) - All	mg/kg	0-10 (2)	3.15E+00	1.47E+00	1.79E+00	2.61E+02	7.00E+00
Res (3) - Groundwater	mg/kg	0-30 (2)	1.05E+00	4.90E-01	5.95E-01	9.16E+01	5.67E+00

Receptors/Pathways and Calculated Exposure Point Concentrations							
Receptor/Pathway	Units	Depth (ft)	Am-241	Ra-226	U-235	U-238	Zr-95
Occ (2) - Air	PCi/g	0-0.5 (1)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Occ (2) - External Radiation	PCi/g	0-4 (2)	5.06E-02	2.29E+00	4.83E-01	2.21E+00	1.34E-01
Res (3) - All	PCi/g	0-10 (2)	3.47E-02	2.94E+00	3.01E-01	1.41E+00	5.36E-02
Res (3) - Groundwater	PCi/g	0-30 (2)	6.28E+00	1.90E+00	1.46E-01	9.71E-01	1.79E-02

#### Assumptions:

The assumed maximum depth of contamination (i.e., 9.1 m [30 ft]) is based on the conservative assumption that downward mobility of chemicals detected in the vadose zone at CFA-13 is 3.0 m (10 ft). Positive detections of COPCs in the vadose zone are reported no deeper than 6.1 m (20 ft).

#### Notes:

- (1) Exposure point concentrations shown for this depth interval represent the 95% lognormal UCL (95 UCL) or maximum detected concentration, whichever is less, for analytical data collected at the site.
- (2) Exposure point concentrations (EPC) shown for this depth interval represent volume-weighted concentrations, and are calculated using the following equations:

Depth (ft)

0-4

0-10

0-30

EPC Equation

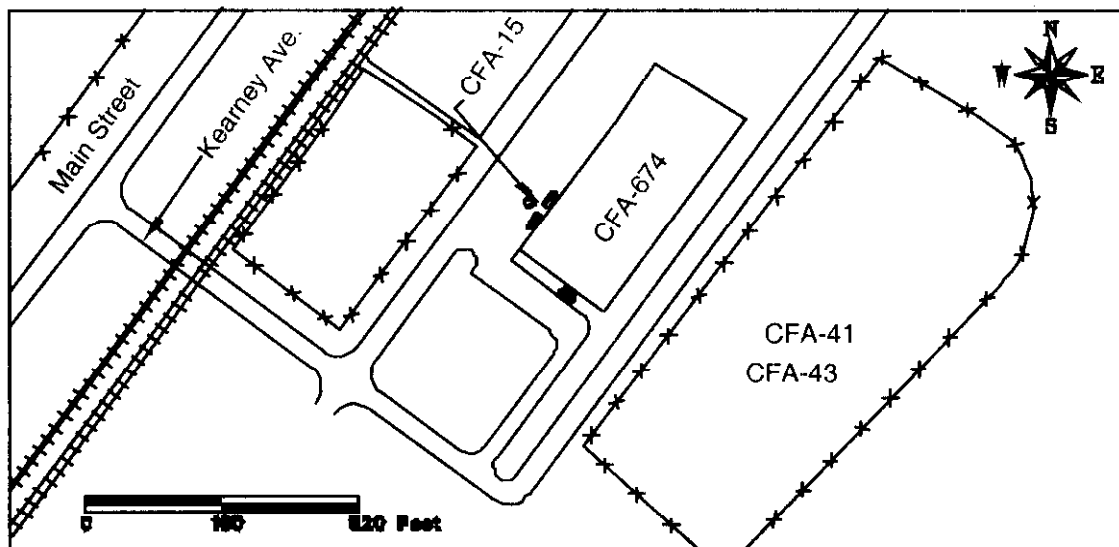
$$[(C_{0-0.5})(0.5) + (C_{0.5-4})(3.5)]/4$$

$$[(C_{0-0.5})(0.5) + (C_{0.5-4})(3.5) + (C_{4-10})(3.5)]/10$$

$$[(C_{0-0.5})(0.5) + (C_{0.5-4})(3.5) + (C_{4-10})(3.5) + (C_{10-30})(20)]/30$$

Where: C=95 UCL or maximum detected concentration, whichever is less, for the indicated depth interval.

**Figure 4-2.** OU 4-02: CFA-13 nature and extent assumptions.



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**Figure 4-3.** OU 4-02: CFA-15 Dry Well (CFA-674).

**4.1.2.2 Previous Investigations.** The Track 1 investigation conducted at this site in 1993 revealed that there was no evidence indicating that CFA-15 was connected to the building by piping. No records were found pertaining to the intended use of the CFA-15 dry well or that the dry well had received waste. Radiological screening of surface soils conducted at the site confirmed the presence of radiological activity. The Track 1 Decision Document recommended no further action at CFA-15 (DOE 1995). However, it was noted during preparation of the OU 4-13 Work Plan that the dry well may have received waste from the laboratory in building CFA-674 similar to that discharged to the CFA-04 Pond. Further investigation at this site was therefore warranted.

This dry well was excavated during the *WAG 4 Miscellaneous Sites 1997 Non-Time Critical Removal Action*, during November 1997. Soil was excavated to a depth of 2.4 m (8 ft) in order to remove the dry well. Piping that was connected to the dry well and the west wall of building CFA-674 was cut and dry packed with grout. After removal of the contaminated soil, three samples were collected and analyzed for metals, VOCs, SVOCs, inorganics, herbicides, pesticides, radionuclides, PAHs, and dioxin. All positively detected chemicals were retained for evaluation in the supplemental contaminant screen presented in Table C-4, Appendix C. The results of the supplemental contaminant screen indicate that Ra-226 is retained as a COPC for further evaluation on the BRA. Ra-226 was detected in 100 percent of 6 samples. The range of detected concentrations for Ra-226 was 1.54 to 2.54 pCi/g. The arithmetic mean for these data is 2.00 pCi/g, which is less than naturally occurring background values detected at other INEEL sites (Giles, 1998).

Aluminum, arsenic, barium, chromium, iron, magnesium, manganese, nickel, potassium, thallium, vanadium, zinc, Sr-90, U-234, and U-238 were not retained because maximum detected concentrations of these chemicals did not exceed background values. Aluminum, barium, chromium, copper, fluoranthene, iron, lead, magnesium, manganese, mercury, nickel, pyrene, silver, vanadium, zinc, Am-241, Eu-155, Ru-106, Sr-90, U-234, U-235, U-238 and Zn-65 were not retained because maximum detected concentrations of these chemicals did not exceed risk-based screening concentrations. Calcium and sodium were not retained because maximum detected concentrations of these essential nutrients did not exceed ten times respective background concentrations.

**4.1.2.3 Nature and Extent of Contamination.** Data from the 1997 removal activities are used in this RI/BRA to characterize the nature and extent of contamination. These data indicate that subsurface soils 0.61 to 4.9 m (2 to 16 ft) bgs at CFA-15 are contaminated with low levels of RA-226. It is assumed that the downward mobility of radionuclides suspended in liquids in the vadose zone (i.e., waste water) is approximately 3.0 m (10 ft). The depth of basalt at CFA-15 is unknown; therefore, contamination is assumed to exist at CFA-15 soils from 0.61 to 7.9 m (2 to 26 ft) bgs. This assumption is made to ensure that potential risks from exposure at CFA-15 are not underestimated (Section 6). This assumption is conservative because sample results are not available for depths greater than 4.9 m (16 ft) bgs; however the entire 0 to 7.9 m (0 to 26 ft) soil interval is assumed to be contaminated.

The extent of the contamination is assumed to encompass the entire site (approximately  $0.3 \text{ m}^2$  [ $0.31 \text{ yd}^2$ ]). The volume of soil associated with the contamination at CFA-15 is  $2.4 \text{ m}^3$  ( $3.1 \text{ yd}^3$ ) (Figure 4-4). The summary statistics for the CFA-15 COPC, based on the contaminant screening process are shown in Tables C-5 and C-6, Appendix C. Figure 4-4 shows the assumptions for the nature and extent of contamination and source-term estimates and exposure point concentrations used to evaluate potential risks associated with the site.

#### **4.1.3 OU 4-05: CFA-04 Pond (CFA-674)**

**4.1.3.1 Site Summary.** This site consists of a shallow pond located southeast of the termination of Nevada Street which was formerly used for the disposal of wastes from operations at CFA-674 (see Figure 4-5). CFA-674 contained the Chemical Engineering Laboratory (CEL) which operated from 1953 until 1965 to conduct pilot studies of a nuclear waste calcining process on simulated (no fuel) nuclear fuel rods. Building CFA-674 is now used as a warehouse and also contains a photography laboratory. There are no current discharges from the building to the pond.

Three waste generation processes were identified as sources of contamination from CFA-674 to the pond in the Track 2 Preliminary Scoping Package: (1) from approximately 1953 to 1965, mercury-contaminated wastes from the calcine development work in CFA-674; (2) from approximately 1953 to 1969, liquid laboratory effluent from the CEL; and, (3) dates unknown, bulky waste including asbestos-containing roofing material from construction projects at the INEEL.

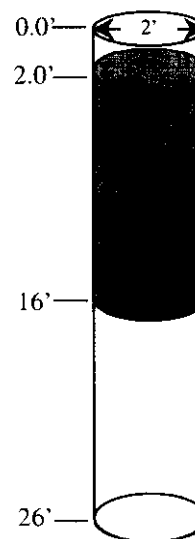
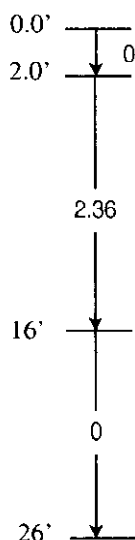
Liquid and solid wastes resulting from operations at the CEL may have included simulated calcine, sodium nitrate, nitric acid, tributyl phosphate, uranyl nitrate, a high grade kerosene, aluminum nitrate as well as hydrochloric and chromic acid, di-chromate solutions, terphenyls, heating oil, zirconium, hydrofluoric acid, trichlorethylene and acetone.


High concentrations of mercury were often present in the calcine because it was used as a catalyst in the dissolution of simulated aluminum nuclear fuel cladding. Effluent from scrubbers on the calciners would also have contained mercury, probably in the form of mercuric nitrate. In a small number of the tests conducted, chemical tracers (chromium, copper, iron, and nickel) or radioactive tracers (Cs-137, Sr-90, Ru-106, and uranium isotopes) were used to characterize parameters of interest in the calcine process. Most calcine was disposed to the pond and buried; however, limited quantities were contained in bottles, which were also buried in the pond.

**4.1.3.2 Previous Investigations.** Sampling and analysis efforts were conducted at the site in 1989, 1993, 1994, 1995, and most recently, 1998. The 1989 sampling was of materials contained in bottles collected from the surface of the pond so that bottles exposed at the surface could be remediated. This cleanup was performed as a maintenance activity prior to the FFA/CO. The concentrations of mercury ranged from 0.25 to 73.3 mg/L, which are above the regulatory level of 0.2 mg/L. In 1993, additional sampling was conducted of the bottled material. Analytical results indicated that mercury levels exceeded

Measured Concentration  
(mg/kg or pCi/g) (1)

Ra-226



 Zone of Contamination

Receptors/Pathways and Calculated Exposure Point Concentrations			
Receptor/Pathway	Units	Depth (ft)	Ra-226
Occupational / Air	PCi/g	0 - 0.5 (1)	0.00E+00
Occupational / External Radiation	PCi/g	0 - 4 (2)	2.22E+00
Residential / All	PCi/g	0 - 10 (2)	2.02E+00
Residential / Groundwater	PCi/g	0 - 26 (2)	2.07E+00

Assumptions:

The assumed maximum depth of contamination (i.e., 8 m [26 ft]) is based on the conservative assumption that the downward mobility of chemicals detected in the vadose zone at CFA-05 is 3.0 m (10 ft). Positive detections of COPCs in the vadose zone are reported no deeper than 4.9 m (16 ft).

Notes:

- (1) Exposure point concentrations for this depth interval represent the 95% lognormal UCL or maximum detected concentration, whichever is less, for analytical data collected at the site.
- (2) Exposure point concentrations (EPC) shown for this depth interval represent volume-weighted concentrations, and are calculated using the following equations:

Depth (ft)

EPC Equation

0-4 
$$[(C_{0-0.5})(0.5) + (C_{0.5-4})(3.5)]/4$$

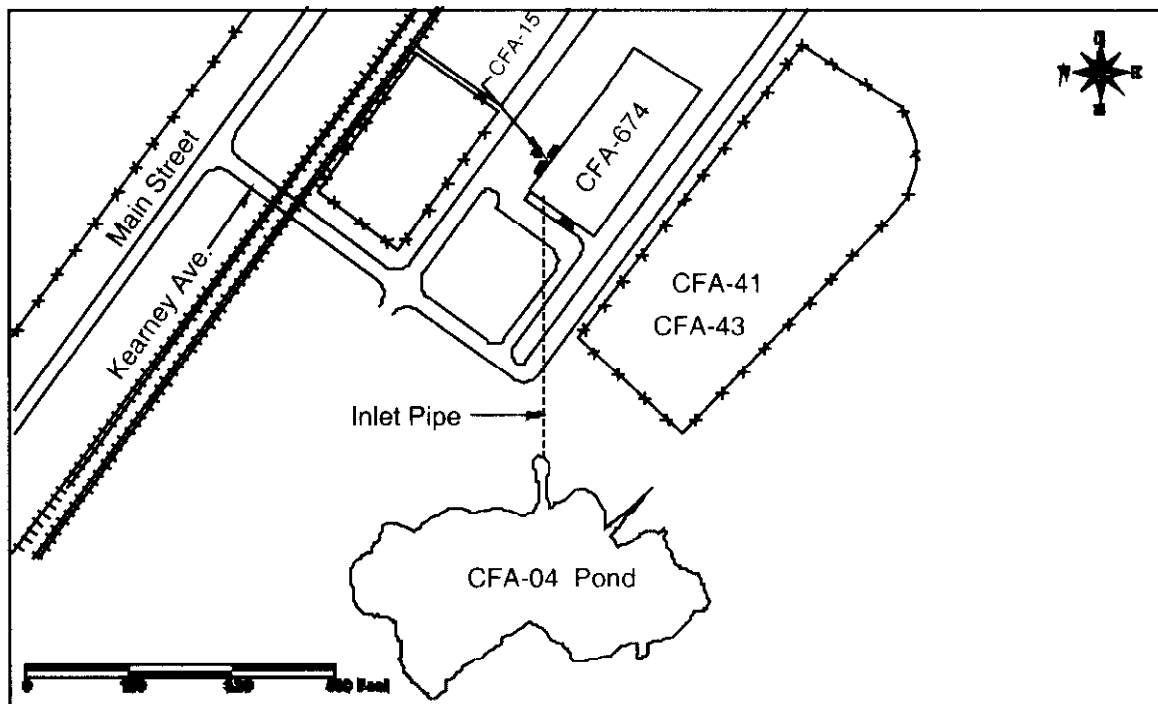
0-10 
$$[(C_{0-0.5})(0.5) + (C_{0.5-4})(3.5) + (C_{4-10})(6)]/10$$

0-30 
$$[(C_{0-0.5})(0.5) + (C_{0.5-4})(3.5) + (C_{4-10})(6) + (C_{10-26})(16)]/26$$

Where: C=95 UCL or maximum detected concentration, whichever is less, for the indicated depth interval.

**Figure 4-4.** CFA-15 assumptions for nature and extent of contamination.





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**Figure 4-5.** OU 4-05: CFA-04 Pond.

the regulatory level, and uranium isotopes and various metals exceeded background concentrations for soil samples. The 1989 and 1993 analytical data were used to initiate a CERCLA removal action at the pond. Surface and subsurface soil samples were collected from the pond and surrounding area in 1994. Analytical results indicated that the soils were contaminated with mercury up to 439 mg/kg.

A time-critical removal action was initiated later in 1994 to remove mercury contamination in the pond. Approximately 2,345 m<sup>3</sup> (3,066 yd<sup>3</sup>) of mercury-contaminated material was removed from the ground including calcine, soil contaminated with calcine, and soil contaminated with mercury from effluent discharges to the pond. Mercury contaminated soil and calcine waste were treated by retorting. However, residual mercury contamination remained in the pond. A small amount of asbestos was also removed from the pond bottom during removal action activities. Non-friable asbestos and roofing material were not disturbed and remained buried in the pond berm.

A Track 2 investigation was conducted in 1995 to characterize residual contamination. Biased surface and subsurface soil samples were collected in the vicinity of the inlet to the CFA-04 pond. A geophysical survey was also performed as part of the investigation to map the distribution of construction rubble, and subsurface metallic objects. The results of the survey indicated geophysical anomalies in two areas; north and west of the CFA-04 pond. The anomalies were believed to be due to elevated soil moisture, soil type change, or the presence of a large volume of conductive, non-metallic material. The shape of the west anomaly, bounded by straight lines, suggested that the feature was a result of human activity. The shape of the northern anomaly was irregular, suggesting elevated soil moisture and/or a soil type change. The identified anomalies north and west of the pond were considered data gaps that required further investigation. The results of the Track 2 investigation sampling indicated that the highest potential human health risks, assuming occupational and residential exposure, were associated with Aroclor-1254, arsenic, mercury, Cs-137, U-234, U-235, and U-238 in the pond soils. The results of the Track 2 risk

assessment indicated that several of these contaminants exceed a risk of  $1\text{E-}06$  and/or a HQ of 1. This site was therefore retained for further evaluation.

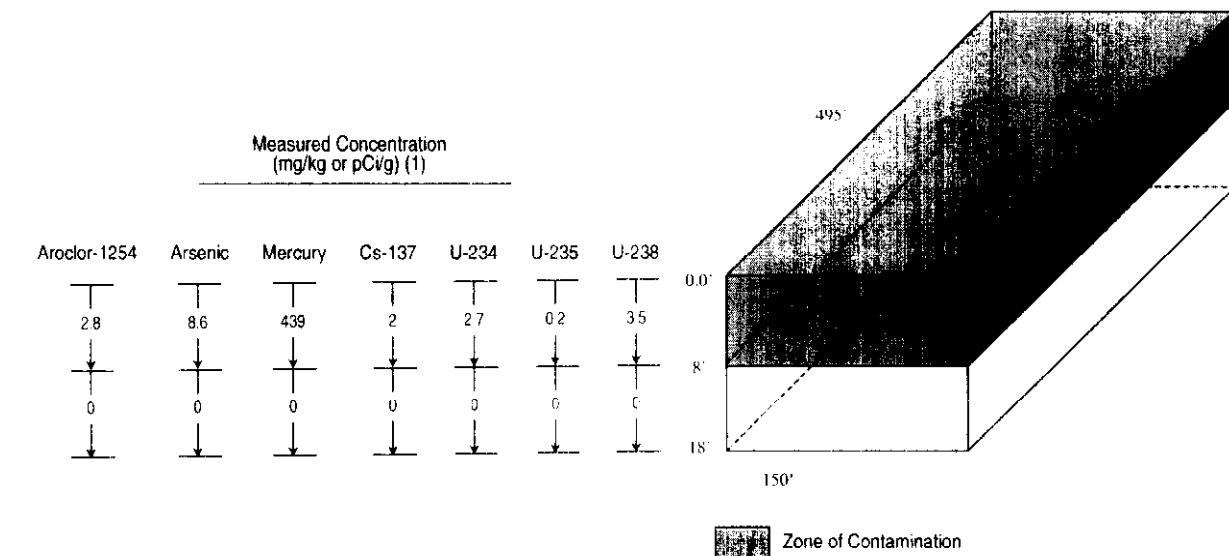
Further sampling was performed in 1997 from the staging area on the north side of the pond where retort equipment was located. The objective of this sampling activity was to determine whether soil contamination occurred as a result of equipment operation and water storage. Samples were collected from 45 surface locations and analyzed for metals, gamma-emitting and uranium radionuclides, and TCLP metals. Mercury was detected at all locations in concentrations ranging from 0.2 to 13.1 mg/kg (Appendix B). These detections indicate that mercury is present in the staging area at concentrations greater than background (0.07 mg/kg) but less than the risk-based concentration (23 mg/kg). The source of mercury is likely windblown calcine from the pond bottom.

The analytical data discussed above was evaluated for the BRA and it was concluded that additional data was required at the pond to define alternatives for the FS. Because mercury was found in the low areas of the pond bottom and in windblown areas around the pond at relatively high concentrations, the volume of soil that would be considered hazardous under RCRA, became a data gap in the investigation. As a result, additional data was collected in 1998. The primary objective of this activity was to collect the type of data that would be used to estimate the volume of mercury contaminated soil that is above considered hazardous under RCRA. Also, additional total mercury samples were collected to better define the extent of contamination in the pond bottom and windblown area.

Mercury was detected in all of the 1998 locations in concentrations ranging from 0.09 to 268 mg/kg. Data from TCLP analysis indicate that three of the 88 locations in the low areas of the pond bottom are RCRA hazardous (Appendix B). The volume of hazardous soil was estimated to be  $608\text{ m}^3$  ( $796\text{ yd}^3$ ) using these data. This volume is used in the feasibility study cost estimates to better define the treatment alternative. These data were also incorporated into the nature and extent of contamination and the BRA (Section 4.1.3.3 and Section 6).

**4.1.3.3 Nature and Extent of Contamination.** Data from the 1994, 1995, 1997, and 1998 sampling activities are used in this RI/BRA to characterize the nature and extent of contamination. Samples were collected and analyzed for inorganics, PCBs, metals, radionuclides, VOCs and SVOCs. The initial contaminant screen presented in the RI/FS Work Plan identified Aroclor-1254, arsenic, carbazole, lead, mercury, Cs-137, U-234, U-235, and U-238 as COPCs. The results of the supplemental contaminant screen, presented in Table C-8, Appendix C, indicates Aroclor-1254, arsenic, mercury, Cs-137, U-234, U-235, and U-238 are retained as COPCs for further evaluation in the RI/BRA. Arsenic was detected in 99.3 percent of 144 samples. Mercury was detected in 92.5 percent of 267 samples. Cs-137 was detected in 68.4 percent of 57 samples. U-234 and U-238 were both detected in 100 percent of 46 and 78 samples respectively for each COPC. U-235 was detected in 78.8 percent of 132 samples. The range of detected concentrations of arsenic was 3.1 to 22.4 mg/kg; mercury, 0.12 to 439 mg/kg; Cs-137, 0.0742 to 2 pCi/g; U-234, 0.651 to 22.6 pCi/g; U-235, 0.0225 to 1.6 pCi/g; and U-238, 0.73 to 35 pCi/g.

These data indicate that surface and subsurface soils 0 to 2.4 m (0 to 8 ft) bgs at CFA-04 are contaminated with low levels of arsenic, mercury, Cs-137, U-234, U-235, and U-238. Arsenic is not associated with known waste producing processes at WAG 4; however, arsenic is retained as a COPC for CFA-04 because the maximum detected concentration slightly exceeds the range of measured concentrations at the INEEL. Past waste producing activities at CFA-04 may have resulted in concentrating naturally occurring levels of arsenic at this site. It is assumed that the downward mobility



Receptors/Pathways and Calculated Exposure Point Concentrations					
Receptor/Pathway	Units	Depth (ft)	Arsenic	Mercury	Aroclor-1254
Occupational / Air	mg/kg	0-0.5 (1)	7.63E+00	1.79E+02	2.80E+00
Occupational / External Radiation	mg/kg	0-4 (2)	9.84E+00	2.57E+02	2.80E+00
Residential / All	mg/kg	0-10 (2)	1.24E+01	1.46E+02	2.24E+00
Residential / Groundwater	mg/kg	0-18 (2)	1.32E+01	1.14E+02	1.24E+00

Receptors/Pathways and Calculated Exposure Point Concentrations						
Receptor/Pathway	Units	Depth (ft)	Cs-137	U-234	U-235	U-238
Occupational / Air	pCi/g	0-0.5 (1)	2.00E+00	5.84E+00	6.93E-01	9.43E+00
Occupational / External Radiation	pCi/g	0-4 (2)	4.51E-01	2.57E+00	3.58E-01	3.47E+00
Residential / All	pCi/g	0-10 (2)	2.75E-01	2.18E+00	1.97E-01	2.55E+00
Residential / Groundwater	pCi/g	0-18 (2)	2.22E-01	2.07E+00	1.49E-01	2.28E+00

#### Assumptions:

The assumed maximum depth of contamination (i.e., 9.1 m [30 ft]) is based on the conservative assumption that downward mobility of chemicals detected in the vadose zone at CFA-13 is 3.0 m (10 ft). Positive detections of COPCs in the vadose zone are reported no deeper than 6.1 m (20 ft).

#### Notes:

- (1) Exposure point concentrations shown for this depth interval represent the 95% lognormal UCL (95 UCL) or maximum detected concentration, whichever is less, for analytical data collected at the site.
- (2) Exposure point concentrations (EPC) shown for this depth interval represent volume-weighted concentrations, and are calculated using the following equations:

#### Depth (ft)

#### EPC Equation

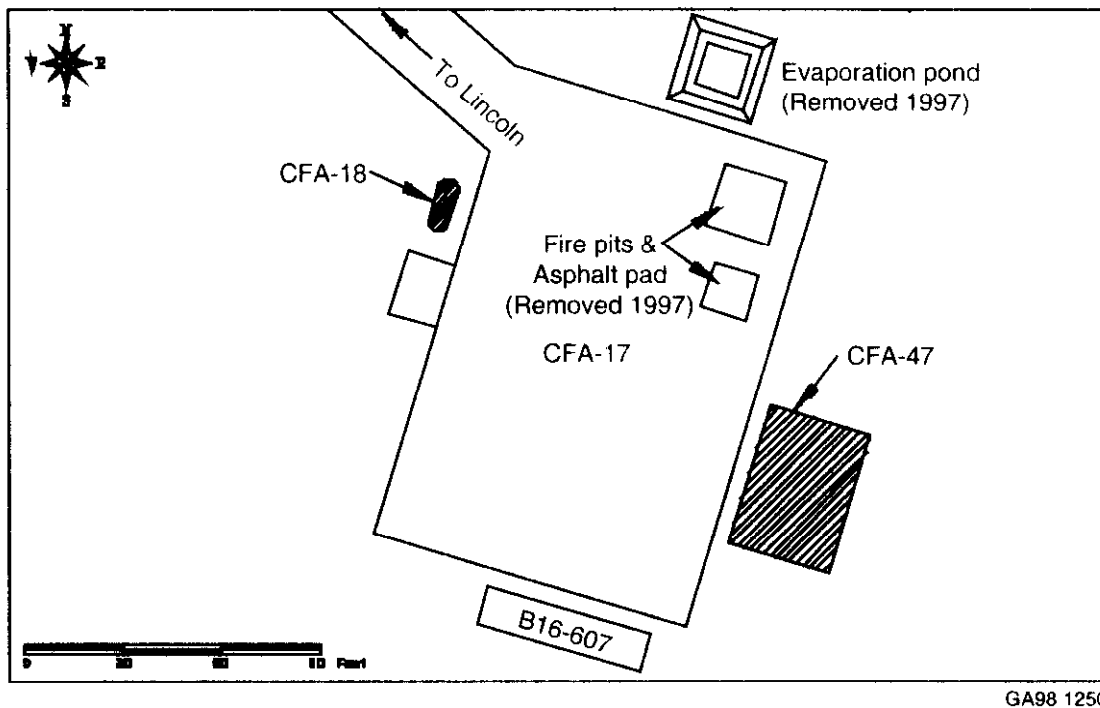
$$0-4 \quad [(C_{0-0.5})(0.5) + (C_{0-4})(3.5)]/4$$

$$0-10 \quad [(C_{0-0.5})(0.5) + (C_{0-4})(3.5) + (C_{4-10})(6)]/10$$

$$0-18 \quad [(C_{0-0.5})(0.5) + (C_{0-4})(3.5) + (C_{4-10})(14)]/18$$

Where: C=95 UCL or maximum detected concentration, whichever is less, for the indicated depth interval.

**Figure 4-6.** OU 4-05: CFA-04 nature and extent assumptions.



**Figure 4-7.** OU 4-05: CFA-17 Fire Department training area (bermed) and CFA-47 Fire Station chemical disposal.

of metals and radionuclides suspended in liquids in the vadose zone (i.e., waste water) is approximately 3.0 m (10 ft). Therefore, contamination is assumed to exist in CFA-04 soils from 0 to 5.5 m (0 to 18 ft) bgs. This assumption is made to ensure that potential risks from exposures at CFA-04 are not underestimated (Section 6). This assumption is conservative because sample results are not available for depths greater than 2.4 m (8 ft) bgs; however, the entire 0 to 5.5 m (0 to 18 ft) soil interval is assumed to be contaminated.

The extent of the contamination is assumed for purposes of risk calculation to encompass the entire site approximately 6,875 m<sup>2</sup> (74,250 ft<sup>2</sup>) to a depth of 3m (10 ft) which includes the pond, the mercury retort equipment staging area, and the windblowing area. The assumed volume of soil would be 20,955 m<sup>3</sup> (16,022 yd<sup>3</sup>) (Figure 4-6) (Blackmore et al. 1996). The summary statistics for the CFA-04 COPCs, based on the contaminant screening process are shown in Tables C-8 and C-9, Appendix C. Figure 4-6 shows the assumptions for the nature and extent of contamination and source-term estimates and exposure point concentrations used to evaluate potential risks associated with the site.

#### **4.1.4 OU 4-05: CFA-17 Fire Department Training Area (bermed) and CFA-47 Fire Station Chemical Disposal**

**4.1.4.1 Site Summary.** The CFA-17 Fire Department Training Area is located approximately 6 km (4 mi) north of CFA, directly east of Lincoln Boulevard with an area of approximately 1,960.6 m<sup>2</sup> (2,349 yd<sup>2</sup>). The training area at CFA-17 was used by the fire department for fire training exercises from 1958 to 1995. The area consists of an old leach pond and a gravel fire training pad. The leach pond was used to collect wastewater from extinguished fires generated during training exercises. This wastewater contained unburned fuel, products of combustion, and possible solvent residue. The gravel training pad was first used to burn fuel directly on the ground. In 1988 the gravel pad was covered with asphalt; and the area was contaminated with petroleum hydrocarbons (Landis et al., 1998). Approximately 18 m

(60 ft) southeast of the CFA-17 asphalt training pad and outside the bermed area, a pile of terphenyls (a brown waxlike substance) and trinitrotoluene (TNT), that resulted from CFA-17 fire station chemical disposal activities, was located at the ground surface in an area approximately 0.93 m<sup>2</sup> (1.1 yd<sup>2</sup>) (see Figure 4-7) (Blackmore et al. 1996). The terphenyl area is designated as CFA-47 under OU 4-05. CFA-17 and -47 are evaluated in the BRA as a single contaminant source area because they are adjacent and contain similar wastes.

Several upgrades have occurred at the CFA-17 fire training area. The first upgrade included installation of piping to divert wastewater to a shallow drainage ditch along the north and east sides of the asphalt pad. A pipe was also installed to connect the ditch to a leach pond. Following this upgrade, wastewater and unburned fuel would drain to the pond via the drainage ditch. A second upgrade occurred in 1987 in which the leach pond and surrounding area were excavated to remove soil contaminated with unburned fuel, combustion products, solvents, and chemicals. This method of disposal was used from 1981 to 1987. The amount of soil removed is unknown. A third upgrade was performed in 1988, which consisted of replacing the leach pond with a lined evaporation pond and adding asphalt paving over the existing gravel pad.

Additional areas were added to CFA-17 in September, 1994. These areas included the soil around and beneath the existing asphalt pad and the soil surrounding the drafting pit east of the fire training tower. Chemicals from various INEEL facilities were burned directly on the gravel pad or in containers at the training area. The soil near the drafting pit was included because unused non-radioactive, sodium-potassium (NaK) from the Experimental Breeder Reactor I was processed in 1970. The drafting pit, normally used to test fire truck pumps, was used to process the NaK. Processing was performed by piping the NaK to nozzles in the bottom of the drafting pit, which was filled with an aqueous solution of sodium and potassium hydroxide. An exothermic reaction occurred when the nozzles malfunctioned, causing the solution to boil and overflow the drafting pit. Approximately 75,700-L (20,000-gal) of the solution drained to the ground in an area east of the pit. The solution contained sodium and potassium salts. The estimated maximum quantity of NaK released during the process was 2,500-L (660 gal).

**4.1.4.2 Previous Investigations and Removal Action.** The Track 2 investigation (Blackmore et al. 1996) conducted in 1995 determined the type and concentration of contaminants originating from the fire training exercises at CFA-17 and determined the extent of terphenyls and other potential contaminants. Soil samples collected from the leach pond and the ditch between the pond and the fire training pad were analyzed for VOCs, SVOCs, metals, and PCBs.

The analytical results of the Track 2 investigation for CFA-17 indicated that acetone, SVOCs, and Aroclor-1260 were detected, and several metals had concentrations above background. The results of the Track 2 risk assessment indicated that HQs are all less than 1, and human health risks above 1E-06 are present for several SVOCs, and arsenic at the leach pond and drainage ditch. CFA-17 was therefore included in the *WAG 4 Miscellaneous Sites 1997 Non-Time Critical Removal Action*.

The Track 2 investigation for CFA-47 (Blackmore et al. 1996) determined the extent of terphenyls and other potential contaminants including metals, VOCs, SVOCs, and PCBs. The results of the Track 2 risk assessment indicated human health risks above 1E-06 are present and all HQs are less than 1. According to the CFA-47 Track 2 Summary Report (Blackmore et al. 1996), PAHs are expected to migrate on the ground surface, through water and/or wind erosion. CFA-47 was therefore also included in the *WAG 4 Miscellaneous Sites 1997 Non-Time Critical Removal Action*.

Excavation activities began August 4<sup>th</sup>, 1997 with removal of the asphalt and concrete burn basins. Discoloration and petroleum odors were evident after removal of these structures indicating the presence of contaminated soil. Excavation of petroleum contaminated soil was guided by visual contamination and data collected by a photoionization detector (PID). Contaminated soil was removed down to basalt at

depths ranging from 3 m (10 ft) at the north end to 7.3 m (24 ft) at south end of the excavation, which represents the varying depths to basalt. The total volume of petroleum-contaminated soil removed from the site was 4,051 m<sup>3</sup> (5,298 yd<sup>3</sup>). Contamination is still present at the site in the basalt. Terphenyls at CFA-47 were removed from the surface soil.

The wastes excavated from the area included petroleum-contaminated soil and sludge, concrete debris from the basins, asphalt, and piping. The petroleum-contaminated soil and sludge was disposed at the CFA Landfarm for treatment. The concrete and asphalt were disposed at the CFA bulky waste landfill. The piping was cleaned and also disposed at the bulky waste landfill. The excavation was backfilled with gravel from the INEEL. Topsoil, from the INEEL spreading area B, was placed on the surface of the backfill and seeded.

The excavation under the asphalt pad area continued until no contamination was observed based on soil color, odor and when PID readings were low to nondetect. Clean backfill for this excavation was obtained from the TSA gravel pit. Soil used for topsoil was taken from Spreading Area "B." This soil was used to provide material for reseeding efforts. Reseeding was performed using a hydroseeder. The total amount of soil removed from CFA-17/47 was 4,051 m<sup>3</sup> (5,298 yd<sup>3</sup>).

**4.1.4.3 Nature and Extent of Contamination.** The initial contaminant screen presented in the Work Plan eliminated metals and SVOCs from further evaluation, and identified Aroclor-1260, arsenic, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, lead, and phenanthrene. The results of the supplemental contaminant screen, presented in Table C-10, Appendix C, indicates benzo(g,h,i)perylene and phenanthrene are retained as COPCs for further evaluation in the BRA. Benzo(g,h,i)perylene was detected in 2.3 percent of 43 samples. Phenanthrene was detected in 4.7 percent of 43 samples. The maximum detected concentration of benzo(g,h,i)perylene was 0.16 mg/kg; phenanthrene was detected from 0.0252 to 0.14 mg/kg.

Arsenic, lead, and Aroclor-1260 were not included in the post-removal action sampling analyses. The arsenic concentrations that were detected in the OU 4-05 Track 2 sampling ranged from 11 mg/kg to 6.1 mg/kg. These concentrations are slightly above the INEEL arsenic background concentration of 5.8 mg/kg as reported in Rood (1995). The contamination generating activities at CFA-17/47 would not have produced arsenic contamination, so the detected arsenic concentrations are believed to be naturally occurring.

The maximum lead concentration that was detected in the Track 2 sampling was 28.5 mg/kg. This concentration is higher than the INEEL lead background concentration of 17 mg/kg, but it is much lower than the 400 mg/kg residential lead clean up standard that has been established by the EPA.

The Aroclor-1260 concentration that were detected in the Track 2 sampling ranged from 0.12 mg/kg to 0.062 mg/kg. Aroclor-1260 was detected in 3 samples out of 13 at a depth of 0-0.5 ft. The maximum detected concentration is slightly higher than the EPA Region III risk-based concentration for PCBs (0.083 mg/kg), so any PCB contamination that remains at the site is unlikely to produce a large impact to human health or the environment.

The omission of these three contaminants from the post-removal action sampling produces some uncertainty in the site's risk assessment. A discussion of the uncertainty produced by undetected contamination can be found in Section 6.6.

Measured concentrations collected at CFA-17/47 indicate that subsurface soils (0.15 to 0.9 m [0.5 to 3 ft] bgs) at CFA-17/47 are contaminated with low levels of benzo(g,h,i)perylene and phenanthrene. During the 1997 removal action, basalt was encountered from 0.9 to 6.1 m (3 to 20 ft) bgs. Residual

contamination is assumed to occur above the 6.1 m (20 ft) assumed site-wide depth to basalt. The residual contamination is not expected to migrate beyond 6.1 m (20 ft) bgs due to the presence of basalt at this depth.

It is assumed that the downward mobility of PAHs suspended in liquids in the vadose zone (i.e., waste water) is approximately 3.0 m (10 ft) (DOE 1997). Therefore, contamination is assumed, for risk assessment purposes, to exist in CFA-17/47 soils from 0 to 4 m (0 to 13 ft) bgs. This assumption is made to ensure that potential risks from exposures at CFA-17/47 are not underestimated (Section 6). This assumption is conservative because sample results are not available for depths greater than 0.9 m (3 ft); however, the entire 0 to 4 m (0 to 13 ft) soil interval is assumed to be contaminated.

The extent of the contamination is assumed to encompass the entire area of CFA-17 and CFA-47 [approximately 1,968 m<sup>2</sup> (21,185 ft<sup>2</sup>) for the entire area: 1,967 m<sup>2</sup> (21,175 ft<sup>2</sup>) for CFA-17, and 0.93 m<sup>2</sup> (1.0 yd<sup>2</sup>) for CFA-47]. The volume of soil associated with the contamination at CFA-17/47 is 7,872 m<sup>3</sup> (10,200 yd<sup>3</sup>) [CFA-17 volume is 7,868 m<sup>3</sup> (10,195 yd<sup>3</sup>) and CFA-47 volume is 12.1 m<sup>3</sup> (130 ft<sup>3</sup>)] (Figure 4-8) (Blackmore et al. 1996). The summary statistics for the CFA-17/47 COPCs, based on the contaminant screening process are shown in Tables C-11 and C-12, Appendix C. Figure 4-8 shows the assumptions for the nature and extent of contamination and source term estimates (i.e., exposure point concentrations) that are used to evaluate potential risks associated with the site.

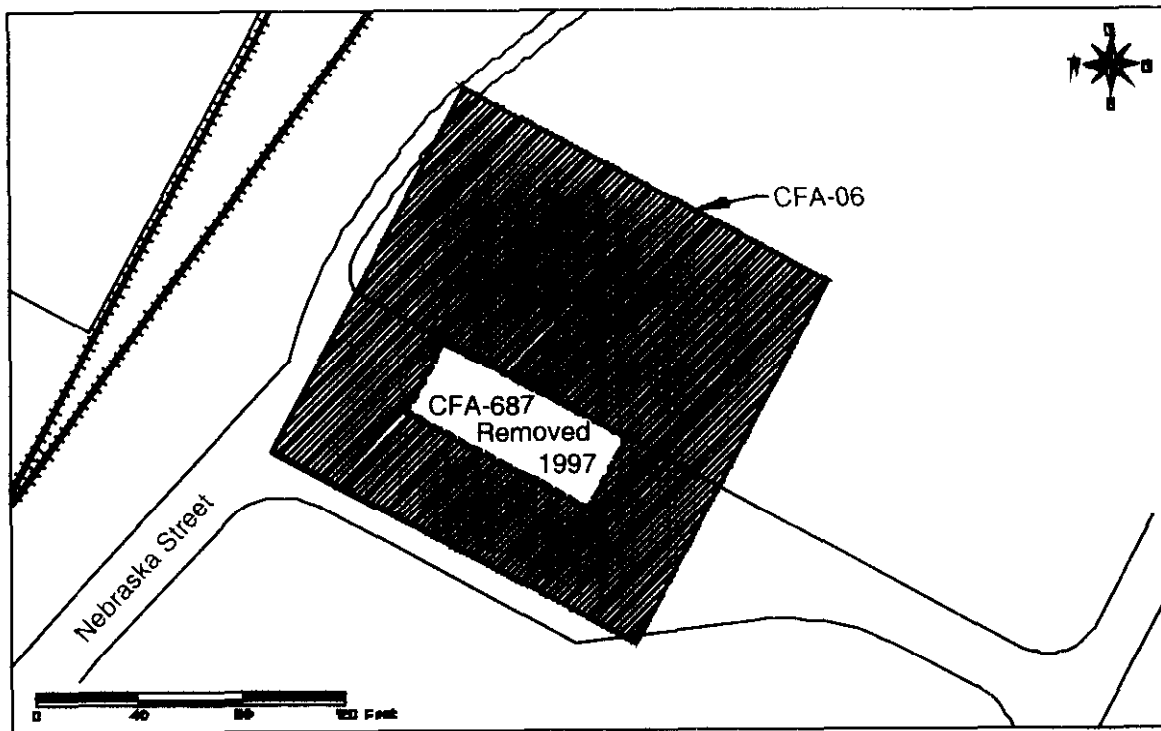
#### **4.1.5 OU 4-06: CFA-06 Lead Shop (Outside Areas)**

**4.1.5.1 Site Summary.** This site consists of the area surrounding Building CFA-687 (see Figure 4-9). CFA-687 was used for lead recycling from 1953 to 1986. Lead scrap from INEEL operations was shipped to CFA-687 and temporarily stored on the ground outside the building until it was processed. CFA-06 is comprised of a 2,529 m<sup>2</sup> (3,024 yd<sup>2</sup>) area, located predominately north and northeast of the previously existing building. No records exist on actual quantities of lead scrap stored near the building. Lead storage resulted in surface and subsurface soil contamination. The lead recycling shop ceased operations in 1986, is no longer used for lead storage or processing and was demolished during the summer of 1997.

**4.1.5.2 Previous Investigations.** This site was included in the OU 4-06 time-critical removal action initiated in June 1996 to reduce the risks associated with lead and arsenic. Pre-removal screening samples were collected at CFA-06 to establish the boundaries of lead contamination. A total of 76 soil samples were collected for lead analysis from the 0 to 15 cm (0 to 6 in) or 15 to 30 cm (6 to 12 in) depths. Sixty of these samples were analyzed for total arsenic. The removal action consisted of removing soil contaminated with lead and arsenic to levels below 400 mg/kg for lead, and 23 mg/kg for arsenic.

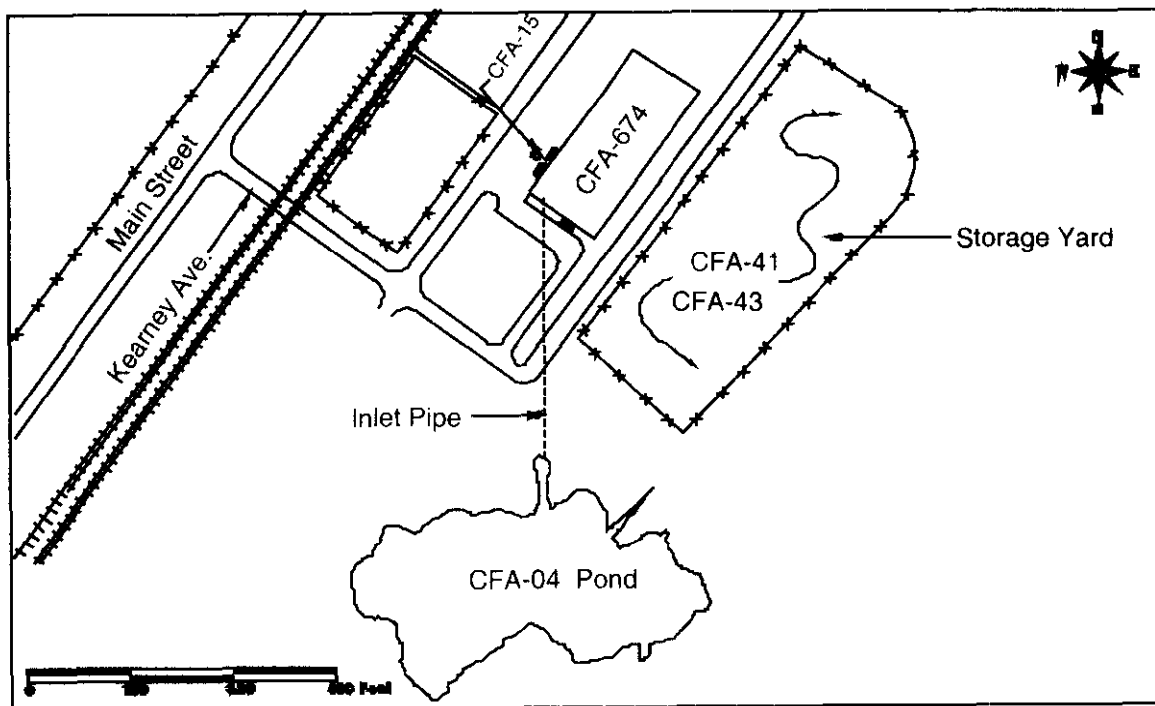
Approximately 153 m<sup>3</sup> (200 yds<sup>3</sup>) of soil, asphalt, lead shot and scrap were excavated. Contaminated soil was shipped off-site to a treatment storage and disposal facility, and lead scrap was recycled. After removal of the contaminated soil, 32 verification samples were collected for total lead analysis and 28 for total arsenic (DAR Nos. ER-DAR-419 and ER-DAR-446) (Higgins 1997). All lead concentrations were below the EPA (1994) lead screening level of 400 mg/kg. All arsenic concentrations were below the arsenic cleanup goal of 23 mg/kg for residential soils.

**4.1.5.3 Nature and Extent of Contamination.** The analytical data from verification samples indicate that residual contamination at CFA-06 consists of low levels of arsenic that exceed the risk-based concentration of 0.43 mg/kg, but are below the 23 mg/kg cleanup goal (detections ranged from 10.4 to 14.5 mg/kg) and lead detected below the 400 mg/kg screening level (detections ranged from 10.4 to 153 mg/kg) in the top 15 cm (6 in) of soil (see Table C-14, Appendix C). Based on the supplemental



GA98 1251

**Figure 4-8.** OU 4-05: CFA-17/47 nature and extent assumptions.



GA98 1261

**Figure 4-9.** OU 4-06: CFA-06 Lead Shop (outside areas).

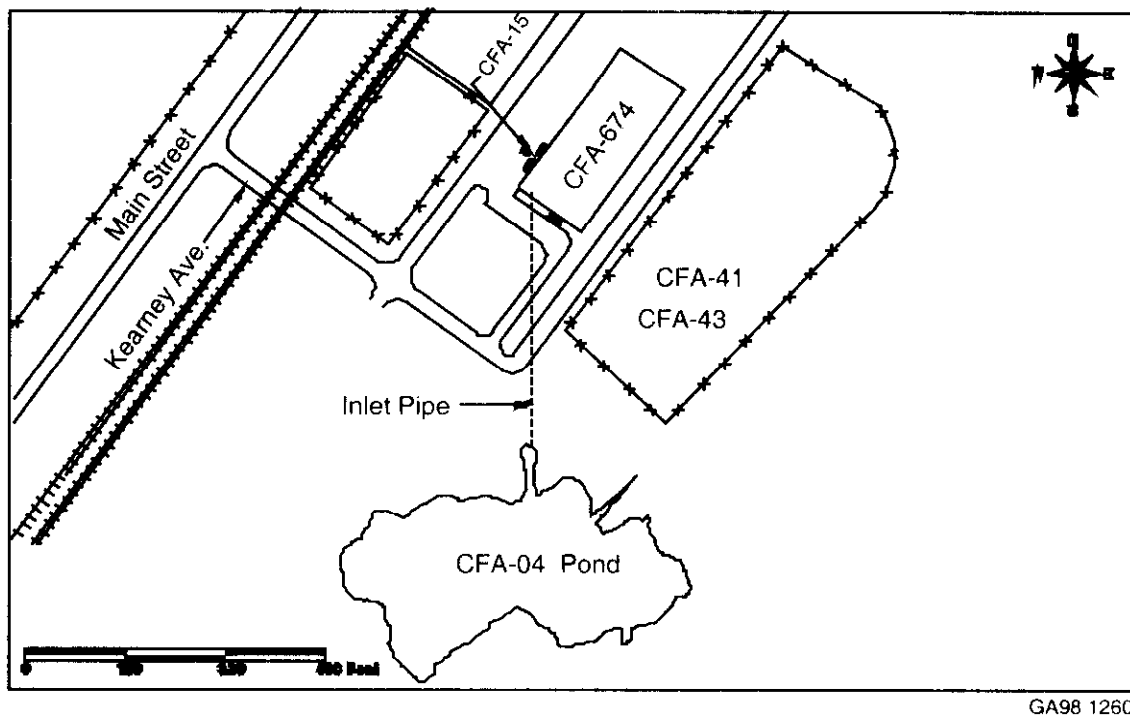


contaminant screening which used the maximum detected verification results, these contaminants are no longer considered COPCs (Table C-13, Appendix C). Detected concentrations of arsenic are not source related and are assumed to be within the range of background concentrations for INEEL soils. Lead is below screening levels. Arsenic and lead are therefore eliminated as COPCs; therefore, this site is eliminated further consideration in the RI/BRA.

#### 4.1.6 OU 4-06: CFA-43 Lead Storage Area

**4.1.6.1 Site Summary.** This site consists of a storage yard south of Building CFA-674 (see Figure 4-10). From 1940 to 1988, this site was used for storage of excess materials, including scrap lead and batteries. In 1988, a molten lead spill of approximately 4.5 kg (10 lb) occurred along the southwest fenced area, which may have resulted in soil contamination. The spilled lead was allowed to harden, was raked up and recycled. The storage area has been regraded several times since 1988. Following the removal action at OU 4-06 in October 1996, the storage area was covered with a clean layer of packed gravel. The area is currently fenced and contains used office furniture and other stored nonhazardous equipment and supplies for private market sale or disposal.

**4.1.6.2 Previous Investigations.** This site was included in the OU 4-06 time-critical removal action to reduce the risks associated with lead and antimony. Prior to removal action activities, pre-removal action sampling was conducted to establish the boundaries of lead contamination at CFA-43. A total of 213 soil samples were collected and analyzed for total lead. Of the 213 samples, 37 were also analyzed for total antimony. Twenty-three total lead samples were greater than the EPA (1994) lead screening level (400 mg/kg). None of the antimony samples exceeded the antimony risk-based screening concentration (31 mg/kg) for residential soils (Higgins 1997); further action was therefore not required for antimony.



**Figure 4-10.** OU 4-06: CFA-43 Lead Storage Area.